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Elevated atmospheric CO_2 enhances daily carbon export from photosynthetic source organs and thus controls the increased growth of vascular plants, tracheophytes.

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Abstract

Introduction: Leaves of the higher vascular plants, tracheophytes, have two primary functions(1). First they serve as organs of C-fixation. Second they are major sources of assimilates for development of 'sink' tissues that also regulate plant growth potential especially at elevated-CO2 (EC).
Methods: A leaf is a heterogeneous structure exporting both in day and night. Organ and organism gas-exchanges and ^{14}C-analyses were integrated showing that quantitatively numerous C3, C3/C4-intermediate and C4 plants export mostly while light energy is trapped and more at EC.
Results: C4's fix and export more than C3'at ambient-CO2(AC). Interestingly, some C3's exporting assimilates, other than sucrose, have translocation rates that proportional to fixation are comparable to C4's. At EC, C3's achieve higher C-fixation rates, and C-export is comparable with C4's. Transition experiments between AC and EC, show that temporary acidification of the apoplast occurs but a brief perturbation of intercellular [H]+ ion levels correlates with only a temporary reduction in assimilate loading and ^{14}C-export. Export is reestablished and source-leaf-strength at EC is greater than AC supporting faster growth.
Discussion: Depending on the stage of canopy development, long-term acclimation to EC can result in a depression in single-leaf-photosynthesis, an observation that merely correlates to a more rapid turnover of key proteins, such as RUBISCO, that are signs of enhanced canopy maturation. Improving crop production necessitates a strategy that maximizes source to sink

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balance throughout the life-cycle. Recent studies, with transgenic lines of *Arabidopsis thaliana*, in which dark respiratory processes associated with pyruvate-flux were targeted (2,3) suggest that daily patterns of canopy photosynthesis, respiration and growth are enhanced at EC. EC not only enhances the metabolism of the (laminar) rosette leaves, but also that of the non-laminar photosynthetic organs (e.g., stems and branches of the inflorescence) that by the time of seed filling can supply over 90% of daily-C-fixed.

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Keywords: assimilate-partitioning, export, photosynthesis, respiration

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